Government of Japan's Approach to High Performance Computing

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CULTURE, SPORTS,
SCIENCE AND TECHNOLOGY-JAPAN

Basic Policy (1)

- ✓ The 3rd Science and Technology Basic Plan (FY2006-FY2010)

  "Next-generation super computing technology" is selected as one of key technologies of national importance

  - ➢ Development and installation of the advanced high performance supercomputer system (10petaflops) → the Next-Generation Supercomputer
  - ➢ Development application software
  - ➢ Establishment of "Advanced Computational Science and Technology Center" (tentative name)

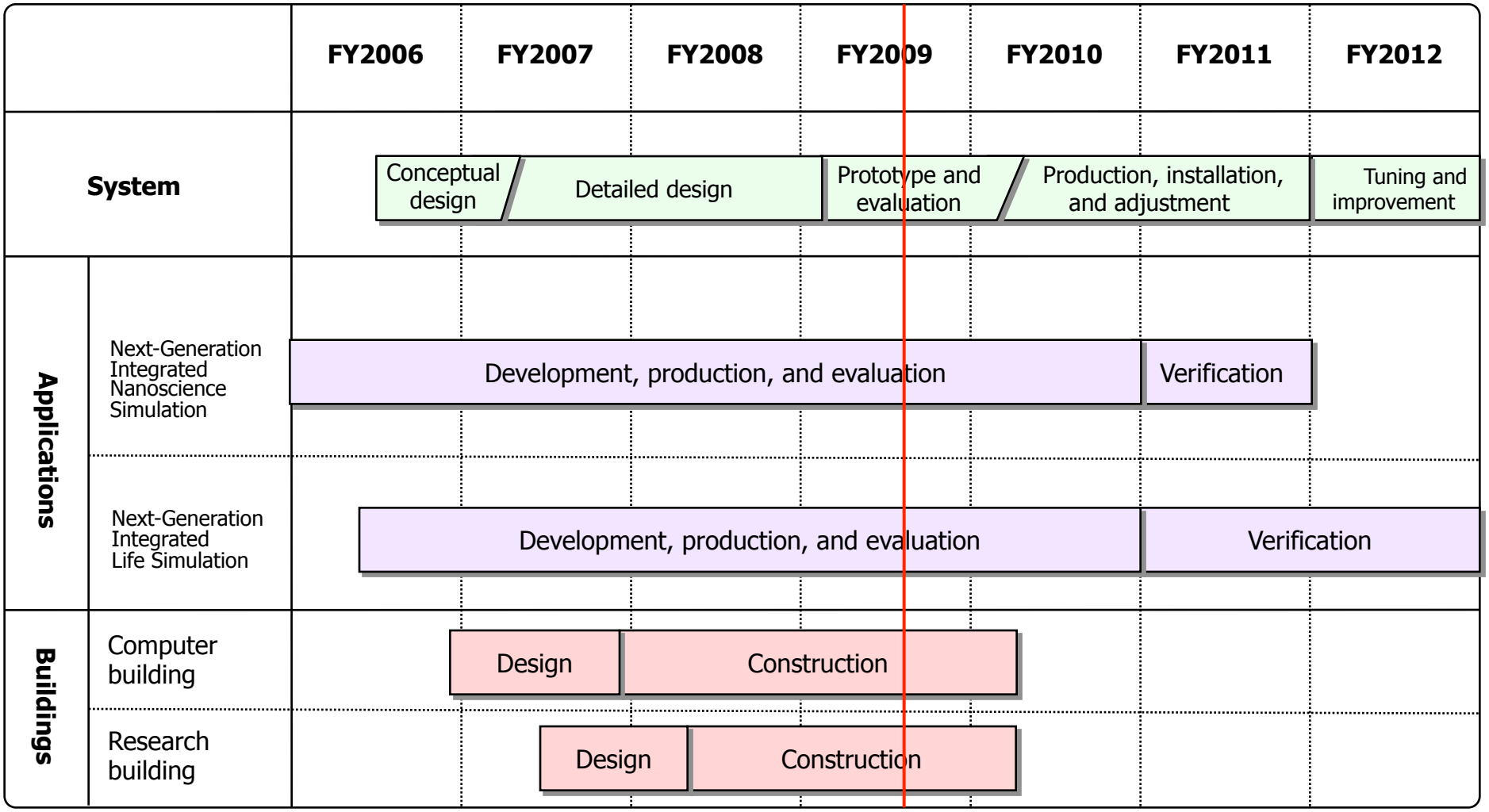
Basic Policy (2)

- ✓ The 4th Science and Technology Basic Plan (FY2011-FY2015) (Now under discussion)
  - ➢ Exaflops class HPC Technology

    New chip device, software, hardware…

The Next-Generation Supercomputer Project

○Schedule



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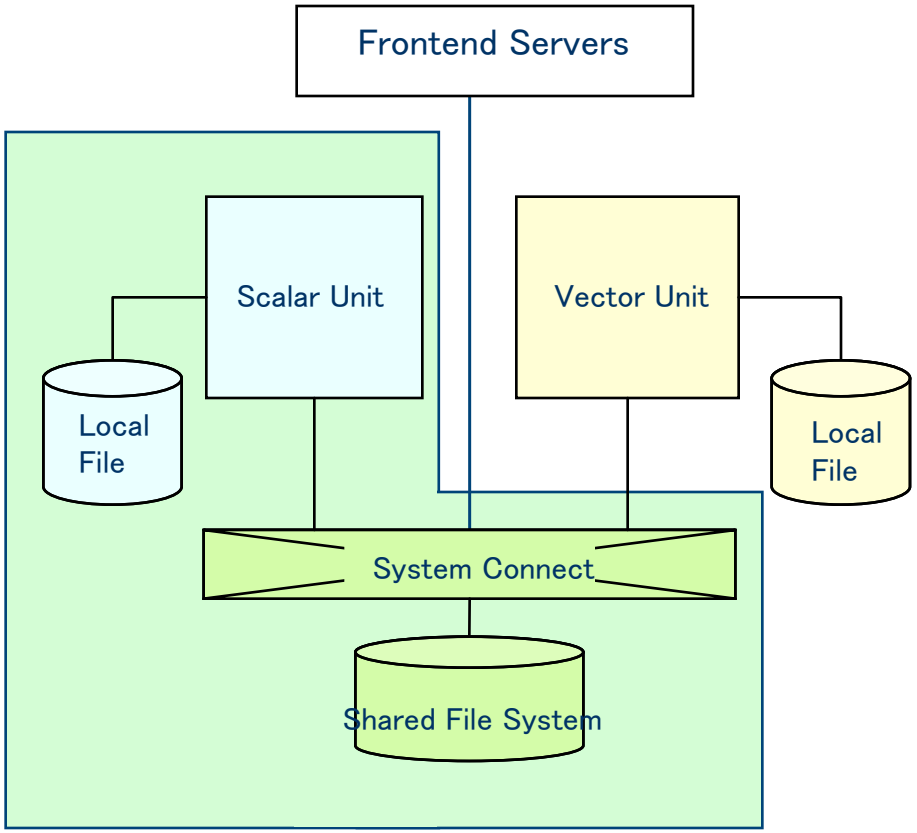
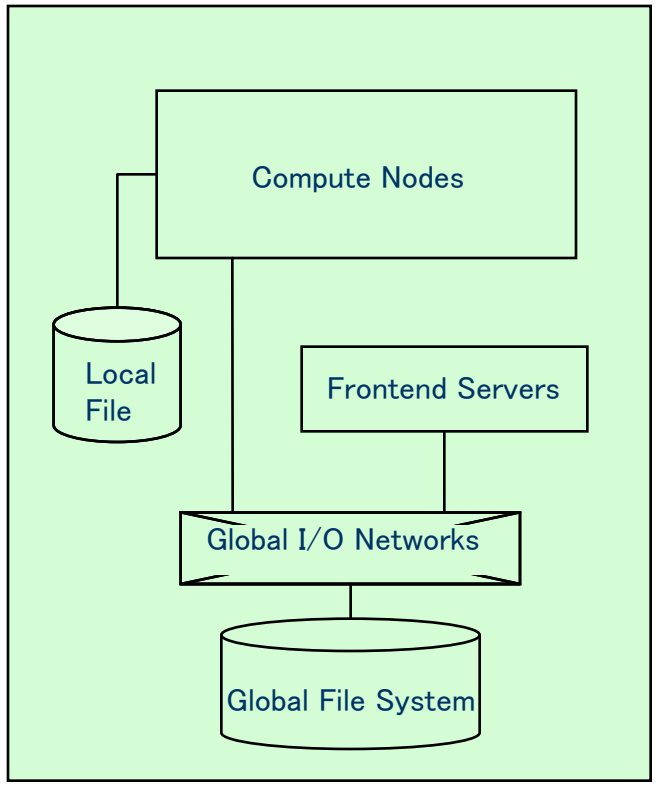
Change of System Configuration

Scalar-Vector Hybrid

Scalar

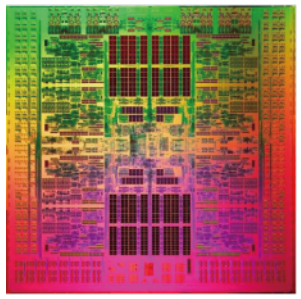




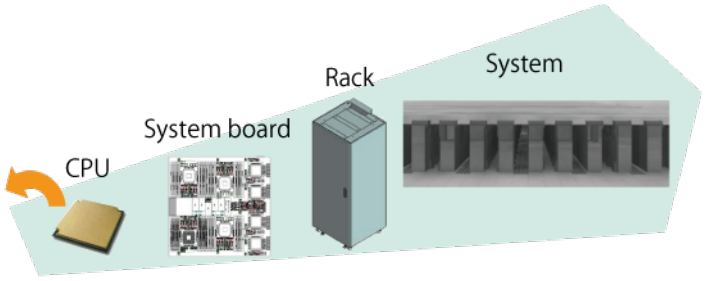
Characteristics of the System

【Massively Parallel/Distributed Memory Supercomputer】

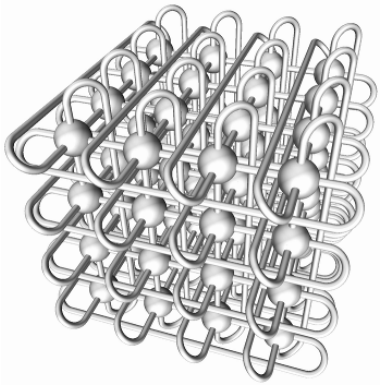
- Ultra high-speed/ high-reliable CPU
  - Advanced 45nm process technology
  - 8cores/CPU, 128GFLOPS
  - Error recovery (ECC, Instruction retry, etc.)
- High performance/highly reliable network
  - Direct interconnection network by multi-dimensional mesh/torus network
  - Expandability and reliablity
- System Software
  - Linux OS
  - Fortran, C, and MPI libraries
  - Distributed parallel file system



SPARC64™ VIIIfx



次世代スーパーコンピュータ（イメージ図）



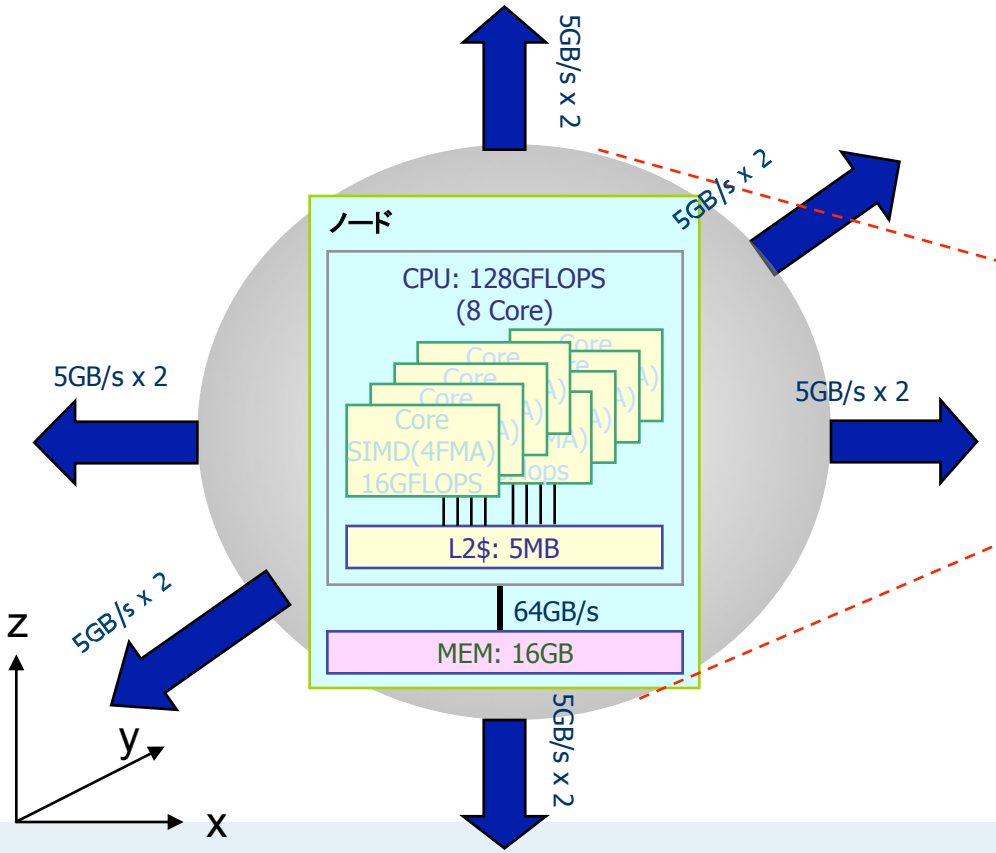
Logical 3-dimensional torus network

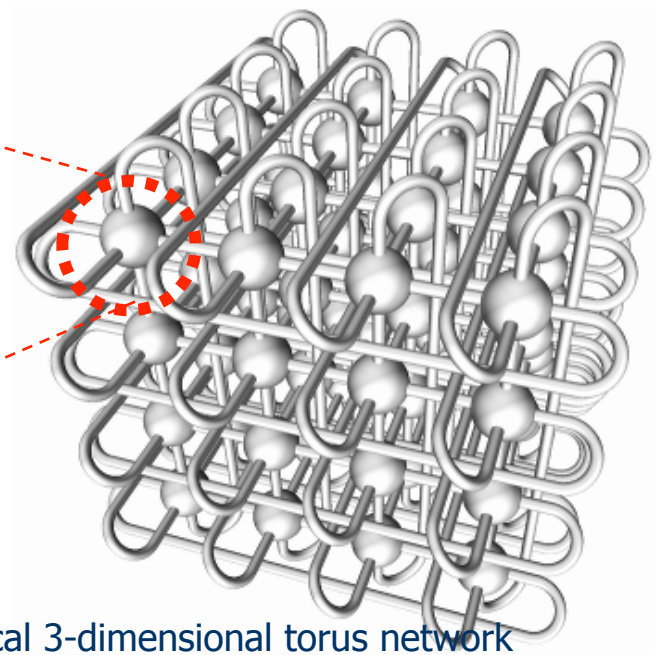
Courtesy of FUJITSU

Configuration of Compute Nodes

- Number of nodes > 80k
  - Number of CPUs > 80k
  - Number of cores > 640k
- Peak Performance > 10PFLOPS
- Total Memory Capacity > 1PB (16GB/node)

- Multi-dimensional mesh/torus network
- Peak bandwidth: 5GB/s x 2 for each direction of logical 3-dimensional torus network
- Peak bi-sectional bandwidth: > 30TB/s

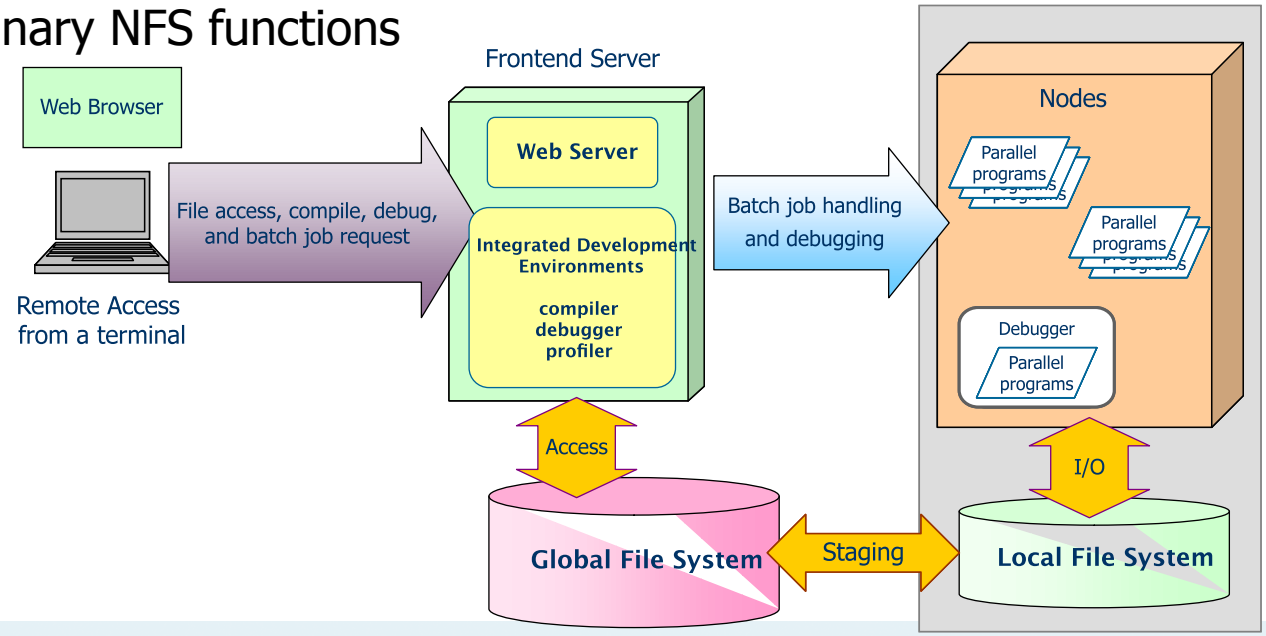




Logical 3-dimensional torus network for programming

User Environments

- OS: POSIX based Linux operating system
- Parallel distributed file system
  - Two-level file system, local and global file system
  - File staging function
    - Stage-in from global to local before job execution
    - Stage-out from local to global after job execution
  - Shared file by ordinary NFS functions
- Batch processing oriented system
  - Interactive environment is planned for debugs.



Location of the Supercomputer Site, Kobe-City

450km (280miles)
west from Tokyo

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Photo: 2008/10/9

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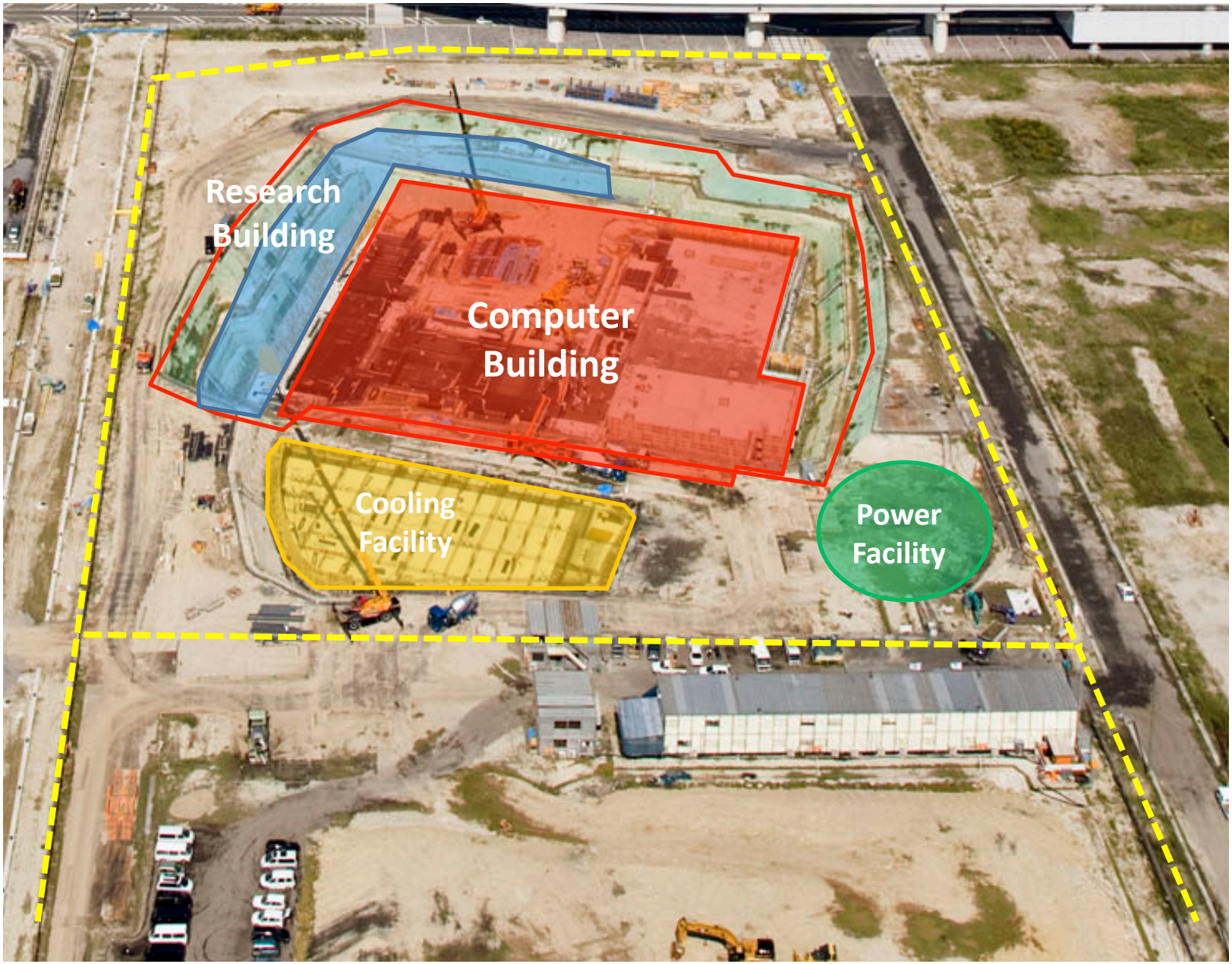

Research Building
Computer Building
Cooling Facility
Power Facility

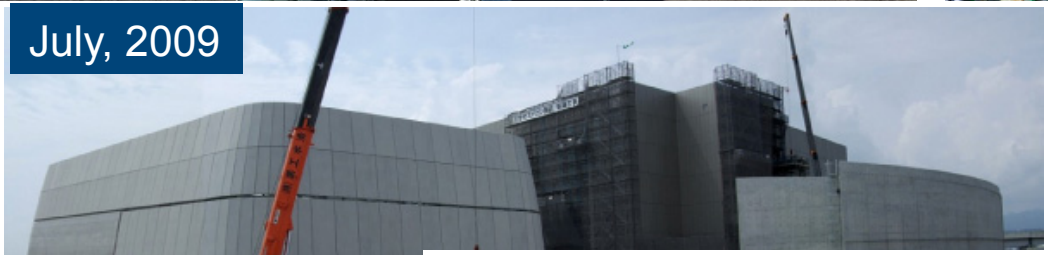
Image of Research and Computer Buildings

Site under Construction

November, 2008

March, 2009

July, 2009



September, 2009

Photo from south-side

Current Policy Issues

- ✓ Efficient use of the NGS
- ✓ Building a framework for promoting HPC
- ✓ Fostering human resources

Efficient use of the NGS(1)

- ✓ Adoption of the following scheme of use :
  - ① Strategic Use:

    MEXT selected 5 strategic fields from national viewpoint.
    - Life science/Drug manufacture
    - New material/energy creation
    - Global change prediction for disaster prevention/ mitigation
    - Monodukuri(Manufacturing technology)
    - The origin of matters and the universe
  - ② General Use:

    The use for the needs of the researchers in many science and technology fields including industrial use and educational use

Efficient use of the NGS(2)

- ✓ Collaboration between Next-Generation Supercomputer and computing machines in universities/research institutes

Next-Generation Supercomputer and computing machines in universities/research institutes collaborate for efficient use of Computational Resources, making adjustment to Next-Generation Supercomputer's applications and improvement of researchers skill.

Efficient use of the NGS(3)

＜Next-Generation Supercomputer＞

- To perform large scale numerical simulation which cannot be performed without using the Next-Generation Supercomputer.

＜Supercomputers in Universities and Research Institutes＞

- To perform middle scale numerical simulations.
- One of the important collaborations with the Next Generation Supercomputer is to provide opportunities for preparation of NGS use.

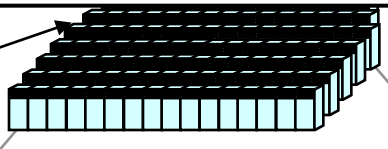
＜Computers in Laboratories＞

- To perform various small scale numerical simulations of many researchers

Efficient use of the NGS(3)

Construction of Supercomputer Network for Science and Technology

Next-Generation Supercomputer

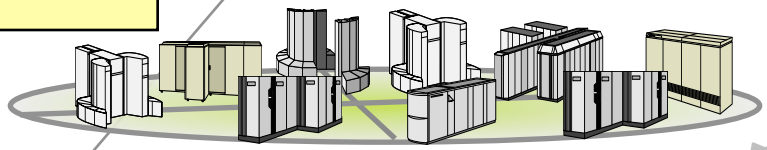


［NLS：National Leadership System ］
For large-scale simulations

Earth Simulator

Private companies, universities and public institutions can use the Earth Simulator mainly in marine earth science field.

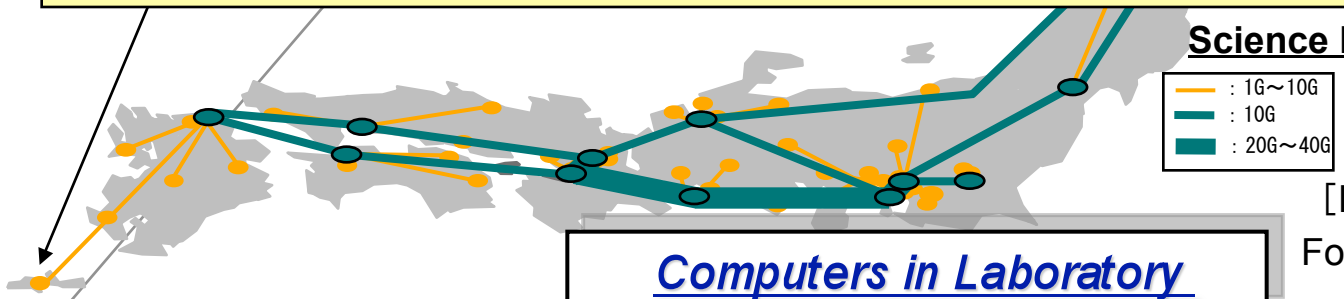
Supercomputers in Universities and Research Institutes (The Earth Simulator, etc.)



［NIS：National Infrastructure System ］
For middle-scale simulations

Supercomputer network in which various scale computers complement each other enables efficient use of computational resources in Japan.

Science Information Network（SINET3）



［LLS：Laboratory Level System ］
For small-scale simulations

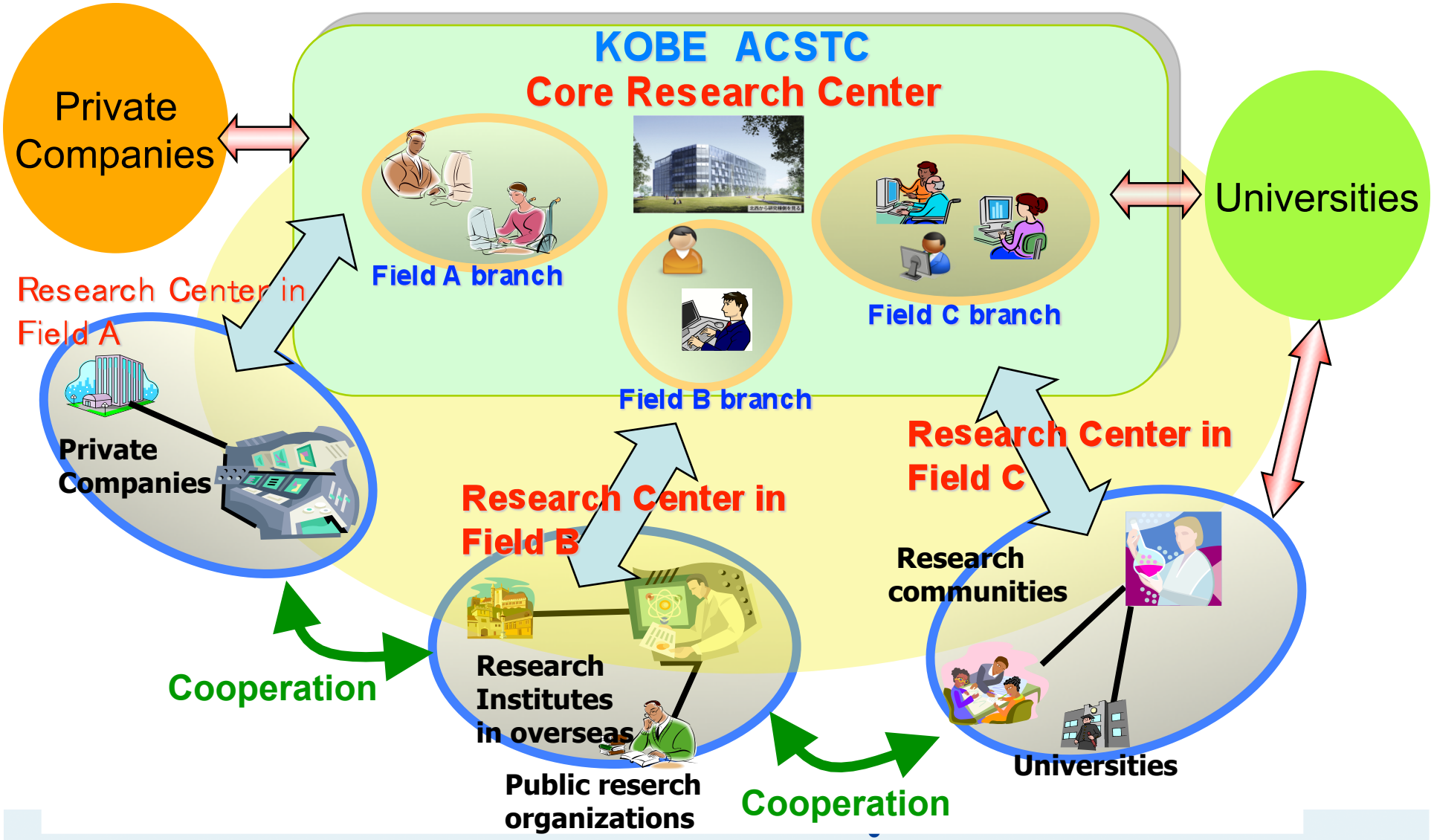
Computers in Laboratory

Seamless computational environment form PC cluster (LLS) to supercomputers (NIS) , furthermore, to the Next-Generation supercomputer (NLS) will be realized.

Building a framework for promoting HPC(1)

- Establishment of "Advanced Computational Science and Technology Center" (tentative name)
- MEXT selects 5 organizations which research in 5 strategic fields
  - ✓ ACSTC → Core research center
    - Conducts advanced and basic R&D in computational science
    - Leads cooperation among strategic fields
    - Provides key knowledge to 5 organizations in strategic fields and another research organizations
  - ✓ 5 organizations → Research center in each field
    - Conducts cutting-edge R&D in each

Building a framework for promoting HPC(2)



Fostering human resources(1)

Basic idea

◆Three elements of scientific methodology

Theory, Experimentation, and Simulation

→ Simulation has established its position as the third element in scientific reasoning

As supercomputers reach ever higher levels of technology and function, the importance of simulation has correspondingly increased

However,

There is a significant shortage of human resources necessary to form the backbone of high-performance computing

⇨ Isn't it possible to take advantage of the advances in the Next-Generation Supercomputer to cultivate personnel?

Yes, it should be done !

Fostering human resources(2)

What kind of HPC people do we need?

People with the ability to cultivate new dimensions of science utilizing super parallel computers

- Advanced Computational Science personnel
- Advanced Computer Science personnel
- Personnel with dual computational/computer science backgrounds
- Personnel with dual experimental/computational backgrounds

Familiarity with Science, Modeling, Algorithms, Software, and Hardware(SMASH) are a given

Fostering human resources(3)

Approaches to cultivating HPC personnel

- Disseminate understanding of SMASH in higher education
- Utilize HPC at the research site
- Establish and promote venues which facilitate cooperation between computational and computer sciences
- Establish and promote venues which facilitate cooperation between experimental research and computational science
- Consciously provide venues for HPC personnel to flourish
- Promote adoption of HPC in industry

Organic industry/academia/government cooperation is imperative!

Fostering human resources(4)